Northeast Coastal and Barrier Network

Protocol Development Summary

(Sept. 2005)

Protocol: Estuarine Nitrogen Inputs

Parks Where Protocol will be Implemented: CACO, GATE, FIIS, ASIS, COLO

Justification/Issues being addressed:

Nutrient enrichment of the coastal zone is a worldwide consequence of human population growth. The Northeast (from Maine to Maryland) currently accounts for about one third of the coastal population of the entire United States (NOAA 1998). The population density of this narrow coastal fringe is more than double that of any other region of the country, and it continues to grow. The consequent residential, agricultural, and urban expansion will result in a continued increase in anthropogenic nutrient loading to the region's coastal zone. Estuaries can generally assimilate some degree of enrichment without major ecological ramifications, but excessive nutrient inputs typically lead to dense blooms of phytoplankton and fast-growing macroalgae, loss of seagrasses, and decreased oxygen availability in sediments and bottom waters (Valiela et al. 1992, Nixon 1995, Borum 1996, Bricker et al. 1999). Cascading effects may include changes in the species composition and abundance of invertebrates, decline in fish and wildlife habitat value, and the collapse of commercially harvestable fin- and shellfish stocks.

For a monitoring program to address questions regarding the causes of estuarine nutrient enrichment and trends in loading rates, monitoring variables must be related to the primary nutrient sources. Nutrients from land-derived sources are delivered to estuaries in surface and ground water flow. Quantifying actual loads of nitrogen and phosphorus requires spatially and temporally intensive measurement of stream and groundwater flux and nutrient concentrations (e.g. Doering et al. 1995, Nielsen 2002), and is beyond the scope of a regional monitoring program. However, the human activities contributing to increased nutrient delivery to coastal waters are well documented and are tractable at the landscape scale. While it would be most desirable to obtain direct measures of nutrient inputs, especially nitrogen (N), to the estuarine waters of the Northeast Coastal and Barrier Network parks, such an effort may not prove to be sustainable over the long term. Surface discharges are event driven and therefore difficult to predict and sample adequately. And while the field collection of surface waters for nutrient analyses is relatively straightforward, acquiring representative ground water samples is technically difficult. The laboratory facilities and staff required to carry out the analytical work for nutrient analyses are probably not within the financial or human resources of most of the parks. For these reasons, a protocol is being developed by the network to monitor estuarine nutrient agents of change, or potential sources of nutrients within the watersheds of each of the parks. These proxy indicators of nutrient enrichment will include such things as: human population numbers, permitted water withdrawals for agriculture, fertilizer consumption, and landuse.

Monitoring Goals, Questions and Objectives to be addressed by the Protocol:

NCBN Goal:

Provide information to NCBN park mangers on the status and trends of park estuarine water quality for use in management decisions and contribute to understanding and describing the condition of marine and coastal areas.

Monitoring Question:
What are the sources of nutrient enrichment to park estuaries?

Monitoring Objective:
Determine long-term trends in nitrogen loading estimations to NCBN park estuaries through nitrogen load modeling that incorporates human population density, atmospheric, fertilizer and wastewater nitrogen sources, non-point source discharge permits, permitted water withdrawals for domestic and agricultural consumption, fertilizer consumption and livestock population data.

Vital Signs:
Estuarine nitrogen loading

Measures: nutrient point source discharge permits, livestock populations, fertilizer consumption, permitted water withdrawals for domestic and agricultural consumption, wet deposition n chemistry

Justification:
The major land-derived sources of nutrient pollution are fertilizers and wastewater (Valiela et al. 1992, Nixon 1995). Nutrients from agricultural fields and domestic septic systems enter streams and groundwater through runoff and leaching, where they contribute to nonpoint sources of enrichment. Domestic wastewater is also delivered to estuaries as point-source sewage discharge. Increasing nutrient loads in streams and groundwater are consequently associated with high rates of urbanization and agricultural expansion. Data on land use within the watersheds surrounding park estuaries are readily available throughout the North Atlantic region as an indicator of nonpoint-source nutrient loads delivered in streams and groundwater, and the number of sewage and industrial effluent discharges permitted in the vicinity of park waters provides data on point-source inputs. Atmospheric deposition of nitrogen from fossil fuel combustion and fertilizer volatilization may also form a significant portion of the total nitrogen load to coastal waters, particularly in estuaries that are large relative to the size of their watersheds (NRC 2000).

Basic Approach:
Agents of Change variables are already gathered by local, state, and federal agencies. Regional testing involves determining the geographic scope of watershed data relevant for each network park, compiling current and historic (at 10-year intervals back to 1970) data from existing sources, and developing trajectories for each variable over time. This analysis will be used to identify the most useful indicators of nutrient load and to prepare guidance for updating the NPS database from other specific sources.

A monitoring protocol is being developed describing in detail how the historic data were compiled and reviewed as well as how to update this inventory, analyze and evaluate the new information for the network on a scheduled basis.

Principal Investigators and NPS Lead:
Protocol development will be completed through cooperative agreement with the University of Rhode Island's (URI) Graduate School of Oceanography.
Principal Investigator: Scott W. Nixon
NPS Leads: Bryan Milstead and Sara Stevens.

Development Schedule, Budget, and Expected Interim Products:
The URI PIs will develop and draft the full inclusive monitoring protocol, to include an extensive narrative describing the full protocol as well as specific SOPs. Peer review, revision and approval is expected by March 2006. The Network budgeted $90,000 in FY 2002 for protocol development.

Literature Cited

Borum, J. 1996. Shallow waters and land/sea boundaries. pp. 179-203 in B. B. Jorgensen and K. Richardson (eds.), Eutrophication in coastal marine ecosystems. American Geophysical Union, Washington, DC.

Bricker, S. B., C. G. Clement, D. E. Pirhalla, S. P. Orlando, and D. R. G. Farrow. 1999. National estuarine eutrophication assessment: effects of nutrient enrichment in the nation's estuaries. NOAA, National Ocean Service, Special projects Office and the National Centers for Coastal Ocean Science, Silver Spring, MD. 71pp.

Doering, P. H., C. T. Roman, L. L. Beatty, A. A. Keller, and C. A. Oviatt. 1995. Water quality and habitat evaluation of Bass Harbor Marsh, Acadia National Park, Maine. Technical Report NPS/NESORNR/NRTR/95-31, National Park Service, New England System Support Office, Boston, MA.

National Oceanic and Atmospheric Administration (NOAA). 1998 (on-line). Population: distribution, density and growth, by T. J. Culliton. NOAA's State of the Coast Report, Silver Spring, MD. http://state_of_coast.noaa.gov/bulletins/html/pop_01/pop.html.

Nielsen, M. G. 2002. Water budget for and nitrogen loads to Northeast Creek, Bar Harbor, Maine. Water-Resources Investigations Resport 02-4000, U.S. Geological Survey, Autusta, ME.

Nixon, S. W. 1995. Coastal marine eutrophication: a definition, social causes, and future concerns. Opheila 41:199-219.

Valiela, I., K. Foreman, M. LaMontagne, D. Hersh, J. Costa, P. Peckol, B. DeMeo-Andreson, C. D'Avanzo, M. Babione, C. Sham, J. Brawley, and K. Lajtha. 1992. Couplings of watersheds and coastal waters: sources and consequences of nutrient enrichment in Waquoit Bay, Massachusetts. Estuaries 15:443-457.

National Research Council (NRC). 2000. Clean coastal waters: understanding and reducing the effects of nutrient pollution. National Academy Press, Washington, DC. 405 pp.